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GHG Emission, National Characteristics and BRI Influence

- An Empirical Analysis of China's Collaborators in the Oil and Gas Industry

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ABSTRACT

With the global de-carbon goals, criticisms regarding the associated "carbon transfer" within The Belt and Road Initiative (BRI) oil and gas cooperation have emerged. These critiques highlight the potential for the BRI to facilitate the long-term transfer of carbon-intensive industries, such as the upstream and midstream sectors of oil and natural gas, from China to signatory countries. This paper aims to investigate and compare the factors influencing the carbon emissions of host countries. Firstly, it examines the effect of external BRI policy on emissions in signatories. Secondly, it explores the impact of host country's internal sociocultural characteristics that may shape its inclination to emission reduction. Thirdly, the study conducts heterogeneity analysis based on the first two aspects. For example, it examines whether gas cooperation is more effective in emission reduction than oil cooperation. Additionally, it assesses whether downstream trade contributes more to emission reduction compared to midstream & upstream business. Moreover, the study investigates whether different cooperation models in upstream business exert varying impacts on carbon emissions. The findings indicate that the internal sociocultural characteristics of the host country exert a considerably greater influence on GHG emission in the energy sector compared to China's BRI. Moreover, variations in the effects do varies between oil and gas; downstream and up-midstream business; as well as various contract modes employed in upstream activities.

Keywords: GHG Emission; Oil&Gas; BRI; Social Culture; Industry Chain; Contract Mode

NONMENCLATURE

Abbreviations	
BRI	Belt and Road Initiative
GHG	Greenhouse Gas
DID	Difference-in-differences
LSDV	Least Squares Dummy Variables
PSA	Product Sharing Agreement
NCP	National Culture Perspective
GGP	Government Governance Perspective
PVP	Public values Perspective

1. INTRODUCTION

The Belt and Road Initiative (BRI) has provided a platform for China to continuously expand and deepen cooperation across the entire oil and gas industry chain internationally. Among countries already engaged in oil and gas business with China, the majority have reinforced their intention for long-term collaboration with China by signing onto the Belt and Road Initiative. Additionally, some countries, although not signatories, still maintain oil and gas business exchanges with China. As the importance of global carbon reduction goals becomes increasingly significant, natural gas, being a cleaner fossil fuel compared to oil, has also become a crucial consideration for Chinese oil and gas enterprises in their international cooperation endeavors.

Meanwhile, criticisms regarding the "carbon transfer" associated with China's BRI have continued to surface. Taking the example of China's overseas investments in the oil and gas industry, concerns are focused on the potential for BRI cooperation to facilitate the transfer of carbon-intensive industries along the oil and gas supply chain from China to partner countries. This, in turn, could exacerbate rather than reduce carbon

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emissions in those countries. Such environmentally detrimental practices, if perpetuated through the long-term implementation of the Belt and Road Initiative policy, may impede global efforts to combat climate change.

The scope of this study is defined within countries that have connections with China in the oil and gas industry chain. The oil and gas industry chain comprises three main segments: upstream exploration and development, midstream refining and transportation, and downstream markets and trading. From the perspective of China, this involves overseas investments in the midstream and upstream sectors, as well as trading activities in the downstream sector. Based on this, a total of 44 countries (including China) have been selected as research samples. The selection of the research period is from 2002 to 2019, based on the availability and completeness of data from various sources.

As of the end of 2019, there were a total of 34 Belt and Road Initiative (BRI) signatory countries and 9 non-signatory countries, with signatory countries accounting for 79% of the total. Regarding the signing timeline (referencing the signing dates recorded on the official Belt and Road Initiative website), since China first proposed the Belt and Road Initiative in September 2013, countries engaged in oil and gas business dealings with China began signing agreements in 2014. Subsequently, countries have continued to sign agreements each year; the year with the highest number of signatory countries was 2018, reaching 15 (coinciding with the peak of signings during the 2018 Forum on China-Africa Cooperation), accounting for 48.39% of the total. In other years, the distribution of signatory countries was relatively balanced, fluctuating around 10%.

In terms of oil and gas business, there were 28 Gas countries and 15 pure oil countries with China in 2019 with China, accounting for 65% and 35% respectively. Regarding the distribution across the entire natural gas industry chain, midstream and upstream projects were present in 14 countries, while downstream product trade and interactions with China existed in 25 countries (Figure 1.); Fig 1-2 lists the situation of all countries engaged in oil and gas business dealings with China.

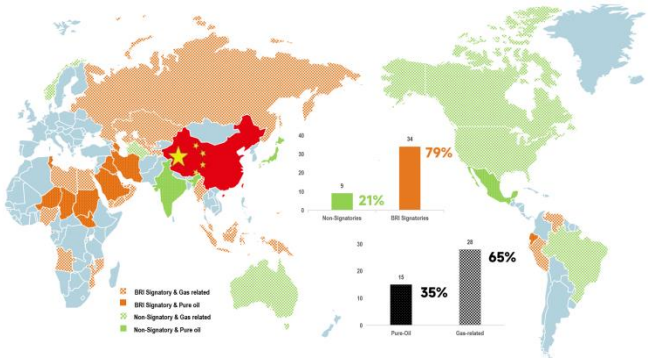

Fig. 1-1 Sample countries

BRI signatories	Gas Related	middle and upper stream	Indonesia, Kazakhstan, Mozambique, Myanmar, Oman, Peru,Russia, Tajikistan, United Arab Emirates, Uzbekistan, Venezuela
		downstream	Algeria, Angola, Bhutan, Egypt, Equatorial Guinea, Indonesia, Kazakhstan, Malaysia, Myanmar, Nigeria, Oman,Papua New Guinea, Peru, Qatar, Russia, Tajikistan,Trinidad and Tobago, United Arab Emirates, Uzbekistan, Venezuela, Yemen
	Pure Oil	middle and upper stream	Azerbaijan, Chad, Ecuador, Iran, Iraq, Nigeria, South Sudan, Sudan, Tunisia
		downstream	Singapore, Kuwait, Saudi Arabia
Non-signatories	Gas Related	middle and upper stream	Australia, Brazil, Canada, Turkmenistan
		downstream	Australia, Norway, Turkmenistan, United States
	Pure Oil	middle and upper stream	
		downstream	Japan, India, Mexico

Fig. 1-2 Countries by category

2. RESEARCH METHOD

2.1 Multi-period Two-Way Fixed-Effect DID Model

Considering Signatories signed BRI treats in different years, a heterogeneous timing Differences-in-Differences (hereinafter referred to as DID) model is used to test the net BRI policy effect. The base model is as below:

$$Y_{it} = \alpha + \sum_{j=-M}^{N} \delta_j BRISIGN_{i,t-j} + \gamma Z_{it} + \lambda_i + \nu_t + \varepsilon_{it} \qquad (1)$$

Y_{it} is a country's GHG emission in the energy sector; γZ_{it} are a set of independent national character variables, in 3 perspectives respectively: National Culture, Government Governance Mode, and Social Value. $\lambda_i + \nu_t$ represents the country fixed effect & time fixed effect; $\sum_{j=-M}^{N} \delta_j BRISIGN_{i,t-j}$ as the interaction (BRI $\times$ Signing year) is a dummy variable to test the net policy effect of BRI. If country i in year t-j signed BRI with China, then the value is 1; otherwise 0 (M and N respectively represent the years before and after the signing year).

Through the implementation of the Least Squares Dummy Variables (LSDV) method on panel data, robust regression estimates were conducted, controlling for both country and year fixed effects as well as BRI group and year fixed effects. Given that country fixed effects offer a finer granularity and a more precise description of individual characteristics compared to BRI group fixed

effects, and their scope is more convergent, the overall adjusted R-squared of the model is expected to be higher. Hence, preference is given to estimation results under the framework of time and country dual fixed effects. Should these results not achieve significance, estimation results under the framework of time and BRI group fixed effects are then considered.

2.2 Parallel Trends Test

The parallel trends assumption is a prerequisite for employing the multi-period DID estimation in empirical studies. It necessitates ensuring that there are no significant differential trends between the treatment and control groups' comparison data before the policy implementation.

We first designate the year preceding the BRI signing as the reference year (baseline), denoted as "pre1" for one year before signing, and "post1" for one year after signing, and so forth. Next, we replace the interaction terms in the DID model with yearly terms *(pre* current post*)* to assess whether there are significant differences between the yearly coefficients and the baseline coefficients. This primarily examines the significance of the pre-baseline yearly terms. If they are not significant, it indicates that there were no significant differences between the treatment and control groups before the intervention, thereby allowing for the estimation of the "net effect" of the BRI policy using a multi-period DID approach.

For the models that passed the parallel trends test, the multi-period DID model is continued to be used for estimation. For the models that did not pass the parallel trends test, robust regression estimation of fixed effects excluding DID variables is performed under the double fixed effects of country and year.

2.3 Placebo Test

The ideal assumption of the model is that the chosen policy variable acts as an exogenous factor, uninfluenced by random elements, thereby allowing for consistent estimator$\hat{\beta}$of the regression coefficient β via Ordinary Least Squares (OLS) estimation. However, in practical scenarios, a given policy is inevitably influenced to varying degrees by numerous factors, some of which are accounted for within the model while others are not. Additionally, due to limitations in including all relevant control variables, the estimation results obtained may exhibit bias. This inherent limitation is expressed as follows:

$$\hat{\beta} = \beta + \gamma \times \frac{cov(Treat \times Post, \varepsilon_{it} \mid W)}{var(Treat \times Post \mid W)} \quad (2)$$

Among these factors, unobservable elements also exert an influence on the explanatory variables. If and only if these elements are uncorrelated with the error term, denoted as γ =0, they will not bias the overall estimation results of the model, rendering it unbiased. However, directly verifying the impact of unobservable factors (due to their inherent unobservability) is impractical. Therefore, indirect methods are employed to assess whether their impact is indeed zero. Within academic discourse, fictitious policy time and fabricated treatment groups are often utilized to operationalize unobservable variables. The fundamental rationale involves identifying a dummy variable $Treat_{fake}$ that theoretically does not affect the results and substituting it for the real variable $Treat$, as illustrated below:

$$Y_{it} = \alpha + \beta Treat_{fake} \times Post + \varphi X + \eta_i + \lambda_t + \varepsilon_{it} \quad (3)$$

The virtual variables $Treat_{fake}$, being randomly generated, differ from the actual state $Treat$, and their actual policy effects ideally should be 0, implying their estimated coefficient β =0. Under this premise, if an estimated coefficient $\hat{\beta}$=0, it can be inferred that the influence of unobservable factor γ is indeed negligible. Conversely, if the estimated coefficient $\hat{\beta}$ of the fabricated "pseudo-policy variable" is non-zero (and significant), it indicates that unobservable factors do exert some influence. Consequently, the variability in the dependent variable might be influenced not only by the real policy but also by other policies or random factors beyond the scope of the original model, rendering the initial model estimations biased.

The placebo test in this paper, based on the aforementioned approach, replaces the real policy variable (DID interaction term) in the multi-period DID model with 500 randomly generated policy variables and estimates them. To provide a more intuitive analysis of the regression results, the robustness of the estimated coefficients of the real policy variables from the original model is assessed through kernel density plots and p-value distribution plots of the coefficients estimated using these *"pseudo-policy variables"*.

2.4 Heterogeneity Analysis

Exploring the Origins of Heterogeneity through Qualitative Subgroup Analysis, Instead of Meta-Analysis.

Besides the BRI & Non-BRI group comparison, the paper also divides countries into gas-related and pure-oil groups. One reason is that many gas projects are associated with oil projects due to geological features. The other is that the gas industry does differentiate from oil in technology and market, which may trigger various

changes involving all social aspects. The gas-related group includes 1) Host countries that launched the Chinese upstream & midstream gas projects with gas production regardless of its proportion; 2) Countries that have downstream gas trade with China. The Pure oil group includes 1) Host countries that launched the Chinese upstream & midstream oil projects with crude oil production only; 2) countries with downstream crude oil trade with China.

The oil and gas industry chain includes upstream exploration and development, midstream refining and transportation, and downstream trade.

Contract modes for international cooperation in upstream oil & gas assets typically include royalty (Royalty), product sharing agreement (PSA), risk service, pure service, buy-back, non-traditional types, and hybrid contract.

3. VARIABLES AND MODELS

All indicator data consist of continuous time series data spanning from 2002 to 2019, totaling 18 years. The data primarily originate from various sources including the World Bank, International Monetary Fund (IMF), BP Statistical Review of World Energy, Hofstede Insights official website, World Values Survey official website, China Belt and Road Initiative official website, and Wood Mackenzie database.

3.1 Dependent Variable

Considering the direct impact of oil and gas operations on the energy sector, the national GHG emission (MtCO2e) from the energy sector for the years 2002 to 2019 are chosen as the dependent variable based on data availability.

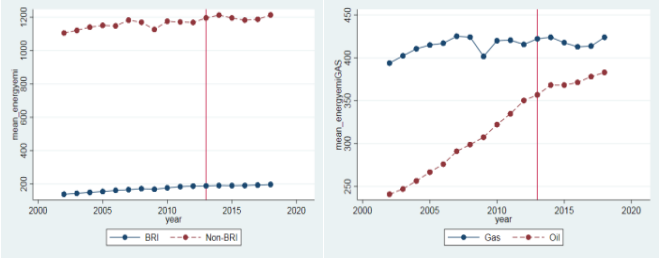

Fig 3.1 GHG Emission - Group Difference

From 2002 to 2019, the GHG emissions from the energy sector of BRI signatories were much lower than non-signatories, and their gap has just narrowed slightly after BRI 2013.

The GHG emissions of gas-related countries were initially much higher than those of pure-oil countries, but as the volume of pure-oil countries increased, their gap has narrowed significantly after BRI 2013.

3.2 Independent Variable

3.2.1 Non-time-varying variable

Hofstede six cultural dimensions represent the host country's National Culture Perspective (NCP).

3.2.2 Time-varying variable

World Governance Index consisting of six dimensions representing the host country's official Government Governance Perspective (GGP).

World Values Survey comprising two dimensions representing the host country's Public Values Perspective (PVP).

3.2.3 Policy Net Effect Variable

The interaction term between country and BRI signing year (BRI Country × Signing Year). Signatory countries are coded as 1, non-signatory countries as 0; years with signing and thereafter are coded as 1, while non-signing years are coded as 0. This variable is used to estimate the net effect of the BRI policy.

3.2.4 Categorical Variable

Production Type. Pure oil vs. Gas.

Industry Chain. Up-Midstream vs. Downstream

Cooperation Mode. Royalty vs. PSA vs. Others.

3.3 Models

Based on the *Multi-period Two-Way Fixed-Effect DID Model* we made the overall together with subgroup models for Heterogeneity studies: (1) Overall, (3) Gas, (5) Pure oil, (7) Up&Midstream, (9) Downstream, (11) Contract-Royalty, (13) Contract-PSA, (15) Contract-Others.

H_0: National Culture (Governance Mode/Social Value) and BRI Policy has no effect on BRI Signatory's GHG emission in the energy sector.

4. RESULTS

4.1 National Culture Perspective

4.1.1 Parallel Trends Test

The models passed the parallel trends test are: (1) Overall, (3) Gas, (5) Pure oil, (7) Upstream and Midstream, (9) Downstream, (13) PSA.

The confidence intervals of the coefficients corresponding to the pre-BRI policy years (Pre14-Pre2) all encompass zero, indicating that the coefficients are not significantly different from zero and exhibit no significant differences compared to the baseline period (Pre1). This suggests that, prior to BRI signing, both signatory and non-signatory groups exhibited similar trends in GHG emission changes. Therefore, the data can

be utilized to compare the "net effect" of the BRI policy implemented thereafter.

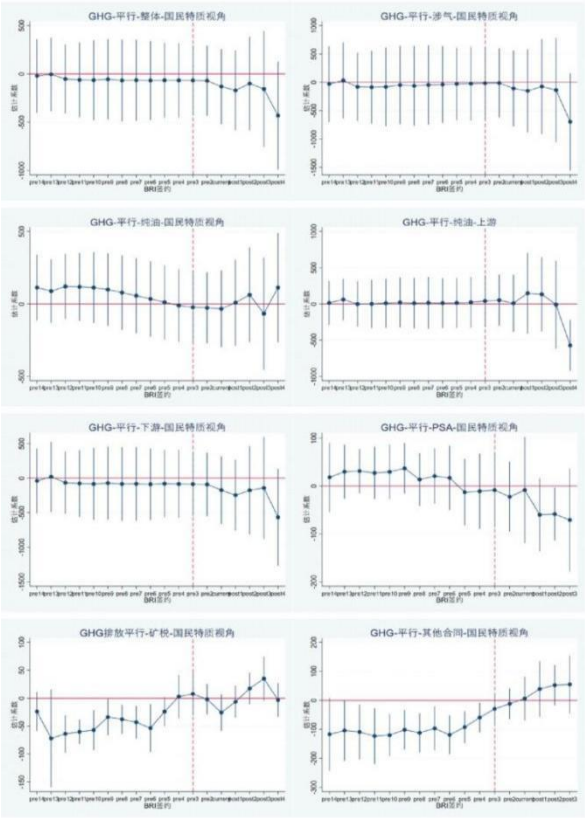

Fig 4.1 Parallel Trends Test in NCP

4.1.2 DID Model Result

For the models that passed the parallel trends test, the multi-period DID model is used for estimation. For the models that did not pass the parallel trends test, robust regression estimates are conducted under the context of country and year double fixed effects, with the DID variables excluded. The specific results are shown in Fig 4-2.

It is observed that only the DID coefficient of the Gas model (Model 3) exhibits statistically significant positive effects at the 95% confidence interval, while other models show no significance. This indicates that for Gas countries, signing BRI might increase the annual GHG emission in energy sector by 52.46 MtCO2e.

Meanwhile, the role and significance of national culture factors are more strong either at the overall level or in subdivided groups. The six factors impacted GHG emission respectively due to the heterogeneity in subgroups.

4.1.3 Placebo Test

The interaction term of BRI signing time and country alone is insufficient to explain whether the increase in GHG emission from the energy sector of host countries is solely due to the policy impact of BRI signing. A placebo test is needed to eliminate the influence of other policies or random factors and to help ensure the robustness of DID estimation results. The placebo test results for Model 3 (Gas) are illustrated in Figure 4-3.

Figure 4-3 displays the estimated coefficient distribution and corresponding p-values of 500 "placebo" variables for Model 3 (Gas). It indicates that the estimation results of the multi-period DID model mentioned earlier may be influenced by other policies or random factors, failed to pass the placebo test. **In the national culture perspective, BRI policy does not significantly affect on the host country's GHG emission in the energy sector.**

	(1) Overall egyemi	(3) Gas egyemi	(5) Oil egyemi	(7) Up&Mid egyemi	(9) Down egyemi	(11) Royalty egyemi	(13) PSA egyemi	(15) Others egyemi
pdi	46.36***	-76.04***	-73.56**	-731.5***	46.44***	25.18***	-6.152***	9.497***
	(4.661)	(7.053)	(31.61)	(13.23)	(4.728)	(0.377)	(0.561)	(0.374)
idv	85.32***	83.62***	-27.60	-1160.6***	85.37***	39.56***	6.603***	-73.07***
	(7.602)	(1.124)	(27.51)	(21.32)	(7.646)	(0.366)	(0.791)	(1.045)
mas	-1.799	24.43***	58.61***	2014.8***	-1.876	-65.67***	58.71***	-158.7***
	(2.327)	(6.304)	(16.55)	(37.29)	(2.395)	(0.639)	(1.959)	(1.247)
uai	-2.870***	127.3***	-16.45***	-1749.2***	-2.841***	49.98***	-15.64***	0
	(0.462)	(12.76)	(4.459)	(32.12)	(0.477)	(0.661)	(0.611)	(.)
lto	24.32***	-8.285	-79.23***	786.4***	24.40***	17.58***	0	0
	(2.777)	(5.317)	(28.49)	(13.68)	(2.852)	(0.188)	(.)	(.)
ivr	13.27***	4.106	-51.00***	-1234.8***	13.31***	48.65***	0	0
	(1.827)	(5.191)	(17.34)	(23.02)	(1.857)	(0.404)	(.)	(.)
DID	5.218	52.46**	-102.7	9.680	-0.315	-	-31.61	-
	(28.32)	(22.90)	(64.21)	(9.966)	(37.95)	-	(20.17)	-
_cons	-7403.0***	-6408.3***	11302.6**	170070.2***	-7420.6***	-6520.2***	-1166.3***	9763.6***
	(664.3)	(258.4)	(4986.4)	(3135.3)	(672.9)	(69.96)	(79.86)	(110.3)
N	510	323	187	255	357	119	85	68
R^2	0.990	0.996	0.946	0.996	0.990	0.998	0.975	0.998
adj.R^2	0.989	0.995	0.936	0.996	0.989	0.998	0.966	0.997
国家	Y	Y	Y	Y	Y	Y	Y	Y
时间	Y	Y	Y	Y	Y	Y	Y	Y

Fig. 4-2 DID Result in NCP

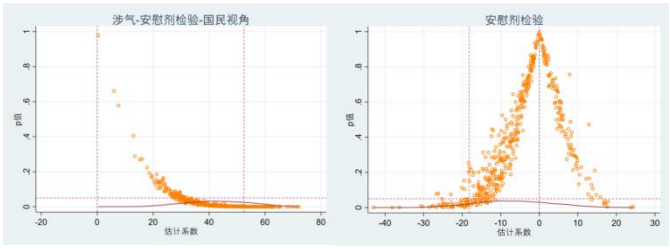

Fig. 4-3 Placebo Test in NCP Fig. 4-6 Placebo Test in GGP

4.1.4 Heterogeneity Analysis

1) Overall

The impacts of National culture are: ***Individualism (+) > Power Distance (+) > Long-Term Orientation (+) > Indulgence(+) > Uncertainty Avoidance(-).*** That is, a country with one unit higher *Individualism* usually has 85.32 MtCO2e more GHG emission in energy sector, while a country with one unit higher in *Uncertainty Avoidance* has 2.87 MtCO2e lower GHG emission.

2) Oil and Gas Difference

Uncertainty Avoidance presented significant opposite & stronger effects between oil and gas. For Gas countries, one unit higher *Uncertainty Avoidance* has 127.3 MtCO2e higher GHG emission; while for oil countries, one unit higher *Uncertainty Avoidance* usually has 16.45 MtCO2e lower GHG emission.

Power Distance showed both negative effect on GHG emission for Gas and Oil countries.

Individualism is only positive for Gas.

Masculinity is positive for both Gas and Oil.

Long-term Orientation and Indulgence are only negative for Oil.

3) Industry Chain Difference

Power Distance, Individualism and *Indulgence* are negative on GHG emission for Up&Midstream, yet positive for Downstream.

Masculinity is only positive for Up&Midstream.

Uncertainty Avoidance showed both negative effect on GHG emission for the whole Industry Chain.

Long-term Orientation showed both positive effect on GHG emission for the whole Industry Chain.

4) Upstream Cooperation Mode Difference

Power Distance is negative for PSA on GHG emission, yet positive for Royalty and others (Service/Buyback).

Individualism is negative for Service and Buyback contracts on GHG emission, yet positive for Royalty and PSA Contracts.

Masculinity is positive for PSA, yet negative for Royalty and others (Service/Buyback).

Uncertainty Avoidance showed significant opposite effects, positive for Royalty but negative for PSA.

Long-term Orientation and Indulgence are only negative for Royalty.

4.2 Government Governance Perspective

4.2.1 Parallel Trends Test

Through parallel trends tests: (1) Overall, (3) Gas, (5) Pure oil, (7) Upstream and midstream, (9) Downstream, (11) Royalty, (13) PSA. Model (15) Other did not pass the parallel trends test (Fig. 4-4).

For the models that passed the parallel trends test, the multi-period DID model is continued to be used for estimation. For the models that did not pass the parallel trends test, robust regression estimation of fixed effects excluding DID variables is performed under the double fixed effects of country and year, as shown in Fig. 4-5.

4.2.2 DID Model Result

In the 95% confidence level, Model (11) has a significant BRI net effect on energy sector's GHG emission reduction in the host country. It means for those countries doing business with china especially in the upstream with Royalty mode, after BRI signing the GHG emission in the energy sector would lower 18.20 MtCO2e.

However, Governance factors, such as Government Efficiency; Rule of Law; and Corruption Control, their significant effects on GHG emission are more either at the overall level or in subdivided groups.

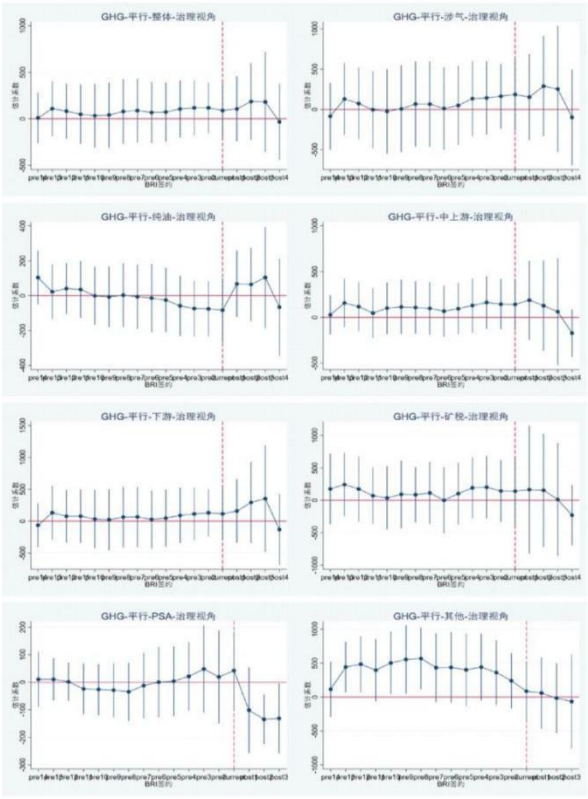

Fig. 4-4 Parallel Trends Test in GGP

	(1) Overall	(3) Gas	(5) Oil	(7) Up&Mid	(9) Down	(11) Royalty	(13) PSA	(15) Others
	egyemi	egyemi	egyemi	egyemi	egyemi	egyemi	egyemi	egyemi
vae	6.252	13.17	-8.283	-2.744	-6.173	-22.88**	75.10***	-15.94
	(12.29)	(21.37)	(19.85)	(7.321)	(30.74)	(10.86)	(22.88)	(25.99)
pve	-12.08	-33.90**	54.70*	-4.707	-8.928	-11.71*	6.769	-14.81
	(12.04)	(13.17)	(32.44)	(5.142)	(19.96)	(6.305)	(5.756)	(9.800)
gee	79.52***	54.38***	60.72	36.91***	98.60***	28.34*	29.67**	60.18**
	(22.45)	(19.47)	(53.16)	(9.977)	(32.69)	(15.64)	(12.82)	(23.18)
rqe	4.014	-8.004	5.839	-11.11	17.22	-35.39**	17.67	33.21
	(15.80)	(19.11)	(51.50)	(8.802)	(23.27)	(17.38)	(15.88)	(24.49)
rle	-88.46***	-13.48	-249.3***	36.93***	-191.8***	57.03**	14.99	34.29
	(30.75)	(26.91)	(77.19)	(12.35)	(54.97)	(21.94)	(18.95)	(31.10)
cce	50.71**	46.55	90.47*	-27.96	109.8***	-9.134	-23.82	-131.8***
	(25.49)	(29.43)	(54.08)	(19.59)	(34.09)	(23.67)	(20.03)	(30.99)
DID	-7.037	18.68	-70.81	-6.653	-12.75	-18.20**	-6.898	-
	(22.23)	(16.95)	(50.31)	(7.582)	(28.49)	(8.905)	(11.75)	-
_cons	609.8***	5674.0***	1038.6***	226.1**	664.6***	309.3***	-2079.9	350.2
	(135.0)	(181.7)	(335.1)	(106.4)	(216.8)	(61.90)	(1755.0)	(423.9)
N	722	476	246	399	493	170	178	136
R^2	0.991	0.996	0.953	0.996	0.991	0.998	0.982	0.998
adj.R^2	0.990	0.996	0.945	0.996	0.990	0.998	0.978	0.997
国家	Y	Y	Y	Y	Y	Y	Y	Y
时间	Y	Y	Y	Y	Y	Y	Y	Y

Fig. 4-5 DID Result in GGP

4.2.3 Placebo Test

The placebo test results of model (11) Royalty failed to pass the placebo test means that **in the perspective of government governance, BRI does not have a significant negative impact on energy sector' GHG emission for the royalty mode countries.**

4.2.4 Heterogeneity Analysis

1) Overall

The impacts of Governance are: ***rle (-)> gee (+)> cce (+).*** A country with one unit higher *rule of law* usually has 88.46 MtCO2e lower GHG emission in energy sector, while a country with one unit higher in *Government Effectiveness* has 79.52 MtCO2e more GHG emission.

2) Oil and Gas Difference

Political Stability has opposite effects on GHG emissions. For a gas country, higher Political stability is more conducive to reduce GHG emissions by 33.9 MtCO2e, while opposite for pure oil.

Rule of law and *Corruption Control* have significant opposite impacts only on the pure oil countries, especially *Rule of law* - one unit higher can reduce more GHG emission.

Government Efficiency is only positively sensitive to Gas countries. Lower *Government Efficiency* had lower GHG emissions.

3) Industry Chain Difference

Rule of law showed significant opposite impacts between Up&Midstream and Downstream. The higher *Rule of law* in Up&Midstream means higher GHG emission, but it is beneficial to lower in downstream.

Government Efficiency and *Corruption Control are only* positively sensitive to Downstream.

4) Upstream Cooperation Mode Difference

Public Accountability is negative for Royalty yet positive for PSA.

Political Stability is only negative for Royalty Contract.

Government Efficiency are positive for all contract modes, especially with Service/Buyback.

Government Regulation is only negative for Royalty Contract.

Rule of law is only positive for Royalty Contract.

Corruption Control is only negative for Service and Buyback Contracts.

4.3 Public values Perspective

4.3.1 Parallel Trends Test

Model (1) Overall, (3) Gas-related, (5) Pure oil, (7) Midstream and upstream, (9) Downstream, (11) Royalty, (13) PSA. The model (15) others did not pass the parallel trend test (Fig 4-6). For the models that passed the parallel test, the multi-period DID model was used for estimation. Otherwise, a robust regression estimation excluding the DID variable was conducted under the double fixed effects of country and year. The specific results are shown in Fig. 4-7.

4.3.2 DID Model Result

Based on the estimation results from the multi-period DID model (Fig. 4-7), it is found that the DID coefficients for the overall effect and for the PSA model (13) are statistically significant at the 95% confidence level. However, the coefficients for other models are not statistically significant.

This implies that for host countries, signing BRI will increases the annual GHG emission in the energy sector by 45.21 MtCO2e within 95% confidence. Particularly for host countries engaging in upstream asset PSA models, there is a 99% likelihood that BRI signing increases their annual average GHG emission by 88.80 MtCO2e.

4.3.3 Placebo Test

The results for models (1) and (13) PSA are shown in Figure 4-8. It can be seen that the overall results of the placebo test of PSA are relatively good, the virtual points are rarely scattered near the true value of the DID coefficient, and most of the virtual coefficients correspond to p-values greater than 0.05 (not significant at the 95% level). This shows that the estimation results of the multi-period DID model are not accidental, and can exclude the influence of other policies or random factors and pass the placebo test. **In the public values perspective, Only for PSA countries, signing BRI will increase energy sector's GHG emission.**

4.3.4 Heterogeneity Analysis

1). Overall

The Only impact: ***Secular (-).*** A country with higher Secular dimension usually has lower GHG emissions in energy sector.

2). Oil and Gas Difference

Secular is only negative to Gas. While *Self-emancipation* is only negative to Oil.

3). Industry Chain Difference

Secular is only negative to Downstream. While *Self-emancipation* is only positive to Up&mid.

4). Upstream Cooperation Mode Difference

Secular is only positive to Service and Buyback Contracts.

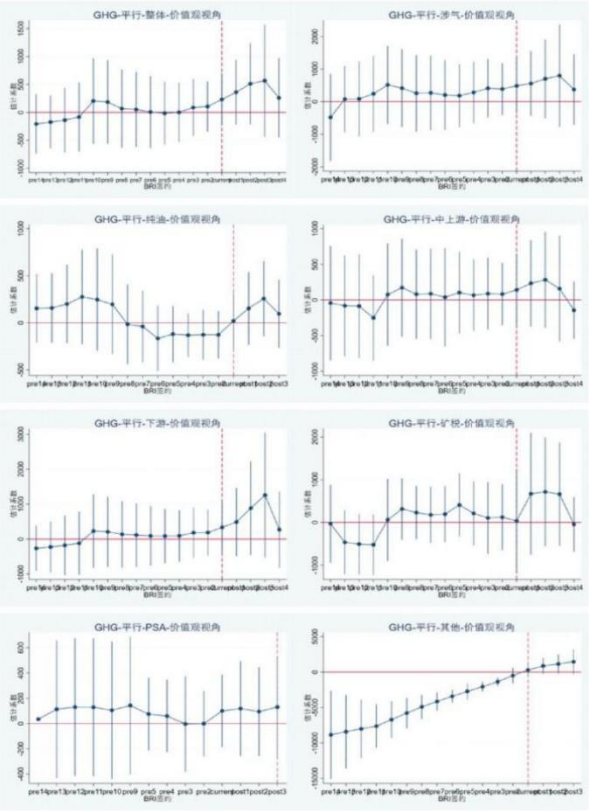

Fig. 4-6 Parallel Trends Test in PVP

	(1) Overall	(3) Gas	(5) Oil	(7) Up&Mid	(9) Down	(11) Royalty	(13) PSA	(15) Others
	egyemi	egyemi	egyemi	egyemi	egyemi	egyemi	egyemi	egyemi
secularv	-594.7***	-332.3*	-326.3	-178.5	-1107.4***	-26.25	7426.8	979.9***
	(216.8)	(184.6)	(335.6)	(172.4)	(423.0)	(91.59)	(4519.3)	(246.5)
emanciv	29.35	95.38	-1293.4**	293.1**	318.2	168.0	-524.8	-1922.7
	(308.4)	(360.3)	(627.5)	(145.8)	(648.4)	(105.5)	(467.7)	(1203.8)
DID	45.21**	42.46	36.67	7.676	39.91	-14.94	88.80***	-
	(21.04)	(28.72)	(24.70)	(12.85)	(29.38)	(9.842)	(18.81)	-
_cons	247.0**	204.4**	398.6	226.1**	318.9**	309.3***	-2536.0	350.2
	(96.99)	(101.7)	(257.6)	(106.4)	(143.7)	(61.90)	(1690.1)	(423.9)
N	332	209	123	168	239	87	35	60
R^2	0.993	0.996	0.963	0.997	0.993	0.999	0.994	0.999
adj.R^2	0.992	0.995	0.952	0.996	0.992	0.999	0.985	0.999
国家	Y	Y	Y	Y	Y	Y	Y	Y
时间	Y	Y	Y	Y	Y	Y	Y	Y

Fig. 4-7 DID Result in PVP

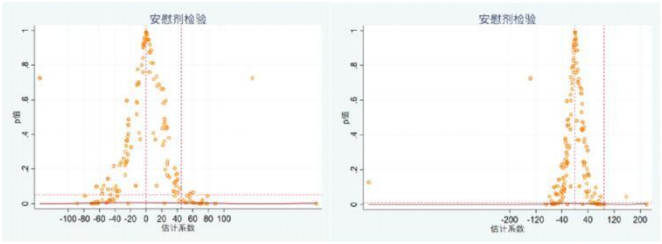

Fig. 4-8 Placebo Test in PVP

5. CONCLUSION AND DISCUSSION

5.1 Conclusion

General speaking, The GHG emission is driven by a country's internal socio-culture rather than external BRI effect from China. As for the internal socio-culture of a country, Public Value influence most, then come Governance and National Culture - a turning point to reduce GHG emission in the energy sector:

secular(-)> rle(-)> idv(+)> gee(+) > cce(+)> pdi(+)> ito(+) > ivr(+)> uai(-)

For a Gas country, more secular, less risk aversion, less individualism, less government efficiency, more political stability and less competition would help lower the GHG emission of the energy sector.

For an Oil country, more self-expression, higher rule of law degree, less corruption control, and long-term orientation would help lower the GHG emission - More than higher power centralization, less competition, higher indulgence and risk aversion.

For a pure-downstream country, more secular, higher rule of law degree, less corruption control, government efficiency and individualism, short-term orientation and less indulgence would help lower the GHG emission of the energy sector.

For an Up-midstream country, less competition, more risk aversion, indulgence, individualism and long-term orientation, less self-expression, lower rule of law degree and government efficiency would help lower the GHG emission of the energy sector.

For a Royalty Contract country, more competition, lower rule of law degree, less risk aversion, less indulgence and individualism, more regulation quality and public accountability, long-term orientation and more political stability would help lower the GHG emission of the energy sector.

For a PSA Contract country, non-BRI signing, less public accountability, less competition, less government efficiency, more risk aversion and less individualism would help lower the GHG emission of the energy sector.

For a Service/Buyback Contract country, less secular, more competition, more corruption control, more individualism, and less government efficiency would help lower the GHG emission of the energy sector.

5.2 Limitation

DV. The per capita GHG emissions within the energy sector may present a more compelling argument.

The potential causal relationship between the non-time-varying factor (national culture) and the time-

varying factor (government governance & public value) remains inadequately explored quantitatively, with a paucity of comprehensive analysis regarding the fundamental and intermediary variables.

Sample Size Considerations. A portion of the sample size, particularly concerning national culture, falls short of meeting the EPV (Events Per Variable) requirement, which typically suggests 10-15 times of the independent variables. More robustness check is needed for further studies.

The explanation of Heterogeneity could be fulfilled with Reason Analysis via Sharp RDD & Fuzz RDD.

Policy Recommendations. The scope of policy recommendations provided in the study is limited. It is essential to offer more comprehensive and practical considerations to address real-world implications effectively. Expanding the breadth of policy suggestions can enhance the applicability of the research findings and contribute to informed decision-making processes.

Causal Relationship Exploration. The potential causal relationship between non-time variables such as national culture and time variables like government governance has not been comprehensively explored quantitatively. Moreover, there exists a dearth of in-depth discussion regarding the fundamental and intermediary variables. Future studies could delve into these aspects to enrich the understanding of causal mechanisms.

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